

# CFT L1 Trigger Design

Trigger Workshop

19-Dec-97

presented by Fred B.

# CFT L1 Trigger design group

- Design Team:
  - Fred Borcharding
  - Marvin Johnson
  - Kin Yip
  - Stefan Gruenendahl
  - Manual Martin
  - Linda Bagby
  - Jameson Olson

# CFT Trigger has 3 functions

- CFT L1 Stand Alone Trigger
  - Number of tracks for Trigger Terms
- Supply Seed for Muon L1 Trigger
  - List of 6 Highest Pt tracks from each FE
- Supply tracks for L2 preprocessors
  - List of tracks for CFT and STT pp's

# Definition Of CFT L1 Trigger Terms

| Term Number |          | Description of Term |         |              |
|-------------|----------|---------------------|---------|--------------|
| Term_15     |          | CFT above           | Highest | Pt Threshold |
| Term_14     |          | CFT above           | High    | Pt Threshold |
| Term_13     |          | CFT above           | Medium  | Pt Threshold |
| Term_12     |          | CFT above           | Low     | Pt Threshold |
| Term_11     |          | CFT/CPS above       | Highest | Pt Threshold |
| Term_10     |          | CFT/CPS above       | High    | Pt Threshold |
| Term_9      |          | CFT/CPS above       | Medium  | Pt Threshold |
| Term_8      |          | CFT/CPS above       | Low     | Pt Threshold |
| Term_7      | isolated | CFT above           | Highest | Pt Threshold |
| Term_6      | isolated | CFT above           | High    | Pt Threshold |
| Term_5      | isolated | CFT above           | Medium  | Pt Threshold |
| Term_4      | isolated | CFT above           | Low     | Pt Threshold |
| Term_3      | isolated | CFT/CPS above       | Highest | Pt Threshold |
| Term_2      | isolated | CFT/CPS above       | High    | Pt Threshold |
| Term_1      | isolated | CFT/CPS above       | Medium  | Pt Threshold |
| Term_0      | isolated | CFT/CPS above       | Low     | Pt Threshold |

# Definition of Track Bits

| Format of Data Words from CFT Front End |            |             |  |   |  |  |             |
|---|------------|-------------|--|---|--|--|-------------|
| Bit #                                   |            | Field Bit # |  | Use   |  |  |             |
| 15                                      | Most Sig.  | 0           |  | Track Found Flag [1=found]                  |  |  |             |
| 14                                      |            | 3           |  | High Threshold Track Match                  |  |  | CPS cluster |
| 13                                      |            | 2           |  | High Threshold Track N / S                  |  |  |             |
| 12                                      |            | 1           |  | Low Threshold Track Match                   |  |  |             |
| 11                                      |            | 0           |  | Low Threshold Track N / S                   |  |  |             |
| 10                                      |            | 0           |  | Sign of the Pt for Track                    |  |  |             |
| 9                                       |            | 3           |  | Inner (A) Layer Offset from Outer Layer Bir |  |  |             |
| 8                                       |            | 2           |  |   |  |  |             |
| 7                                       |            | 1           |  |   |  |  |             |
| 6                                       |            | 0           |  |   |  |  |             |
| 5                                       |            | 5           |  | Outer (H) Layer Phi Bin                     |  |  |             |
| 4                                       |            | 4           |  |   |  |  |             |
| 3                                       |            | 3           |  |   |  |  |             |
| 2                                       |            | 2           |  |   |  |  |             |
| 1                                       |            | 1           |  |   |  |  |             |
| 0                                       | Least Sig. | 0           |  |   |  |  |             |
|   |            |             |  |   |  |  |             |

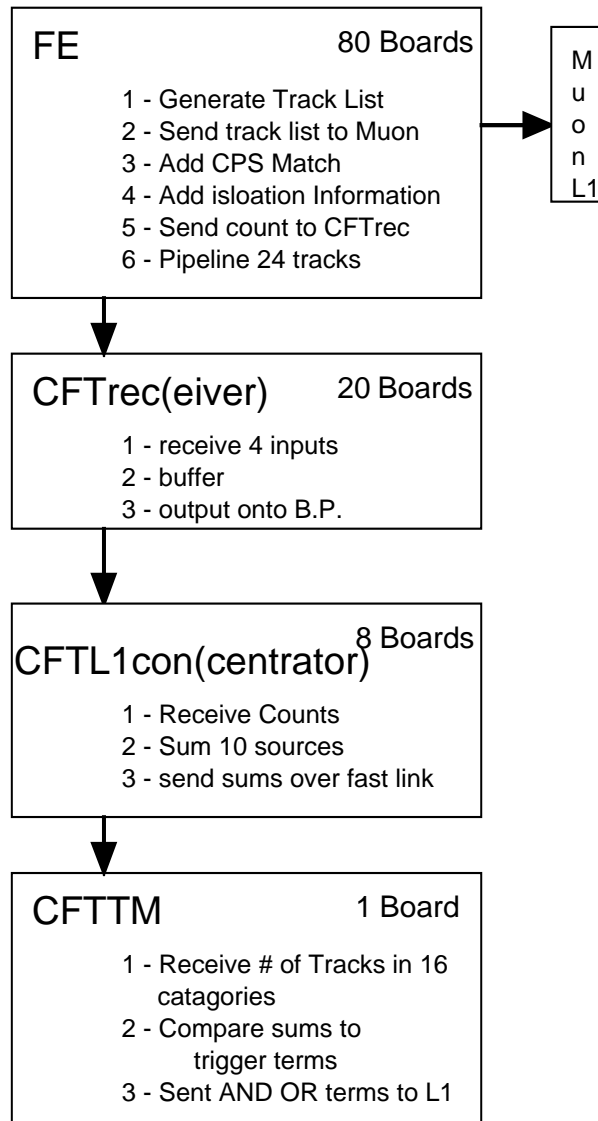
# Pt for Offset Bins

- Track Pt as a function of bins offset
- The first column is the bins offset
- The numbers are from histograms of the Pt which were generated by a MC that generated tracks over all outer bins for a sector

| Offset | Min   | Mean  | Max   |
|--------|-------|-------|-------|
| 0      | 18.00 | 21.40 |       |
| 1      | 9.00  | 16.90 |       |
| 2      | 6.50  | 11.00 | 21.00 |
| 3      | 4.50  | 6.80  | 10.50 |
| 4      | 4.00  | 5.00  | 7.00  |
| 5      | 3.25  | 3.90  | 5.00  |
| 6      | 2.75  | 3.30  | 4.00  |
| 7      | 2.50  | 2.80  | 3.50  |
| 8      | 2.20  | 2.40  | 2.80  |
| 9      | 1.80  | 2.20  | 2.50  |
| 10     | 1.80  | 1.90  | 2.20  |
| 11     | 1.60  | 1.76  | 2.00  |
| 12     | 1.50  | 1.62  | 1.80  |
| 13     | 1.40  | 1.53  | 1.60  |

## Functional Description

Every Crossing ( 132 ns ) *Gen\_pic1*

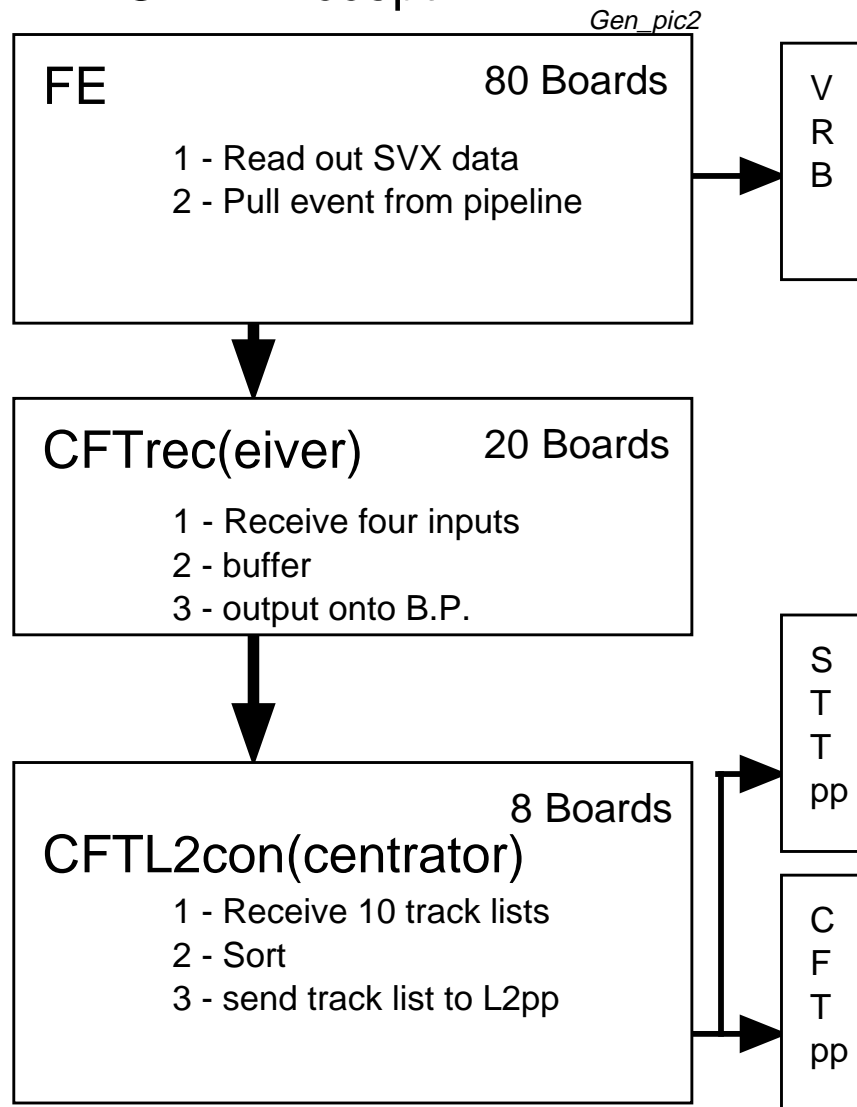


# L1 Function of System

- FE
  - (pipeline)
  - 2nd copper link
- CFTrec
  - new
- CFTL1con
  - new
- CFTTM
  - new
  - Muon developed hardware

# Functional Description

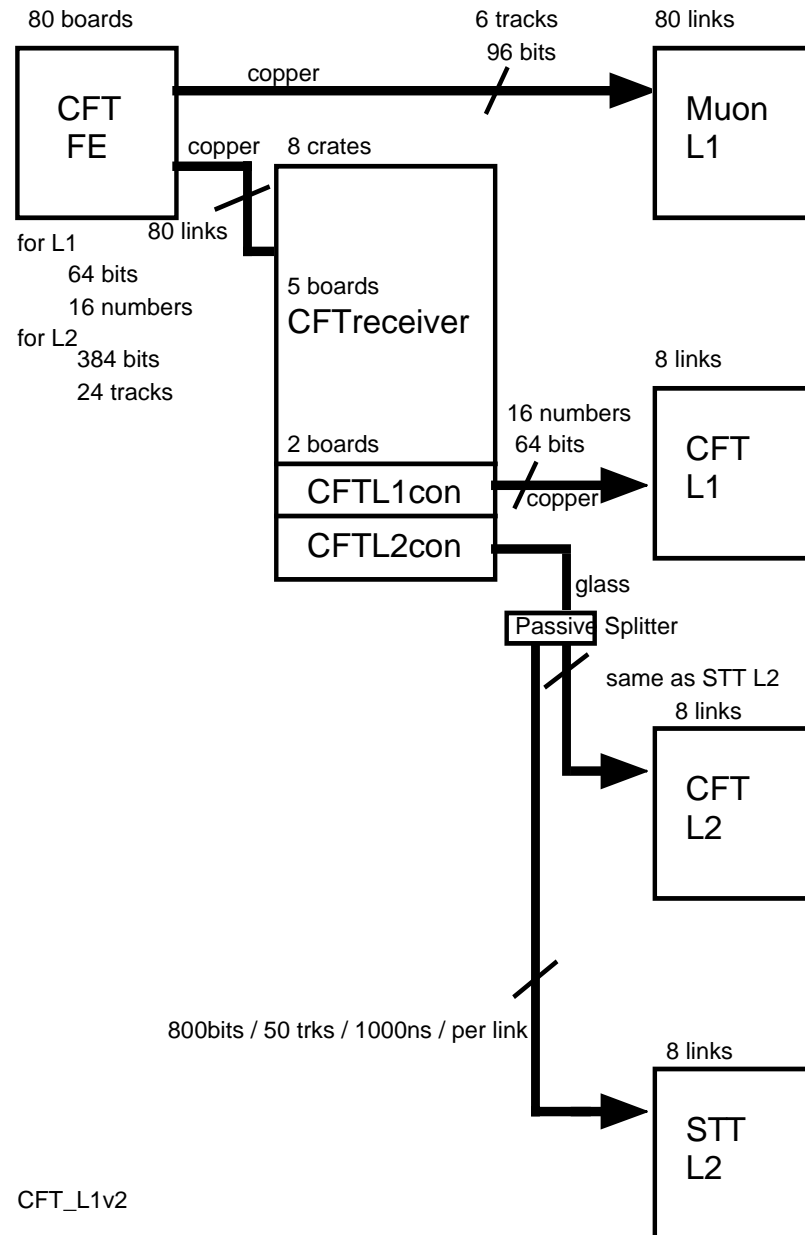
On L1 Accept



## L2 Function of System

- FE
  - pipeline
  - (2nd copper link)
- CFTrec
  - (new)
- CFTL2con
  - new
- L2pp Link
  - new
  - Glass fiber link





# Overall System Design

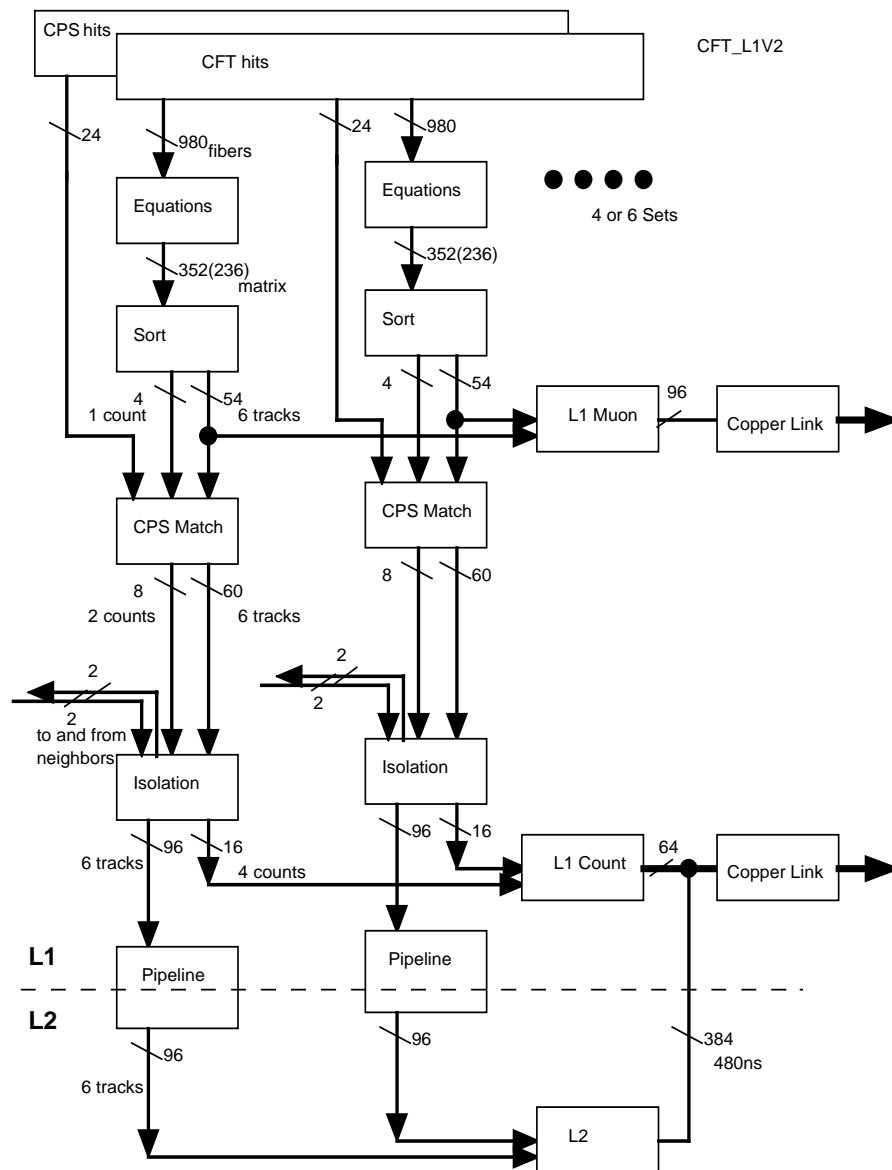
- 80 CFT Fes
- 4 Crates - west
  - 5 Receivers
  - 2 L1 concentrators
  - 2 L2 concentrators
- L1 Muon
- CFT L1
- L2pp

CFT\_L1v2

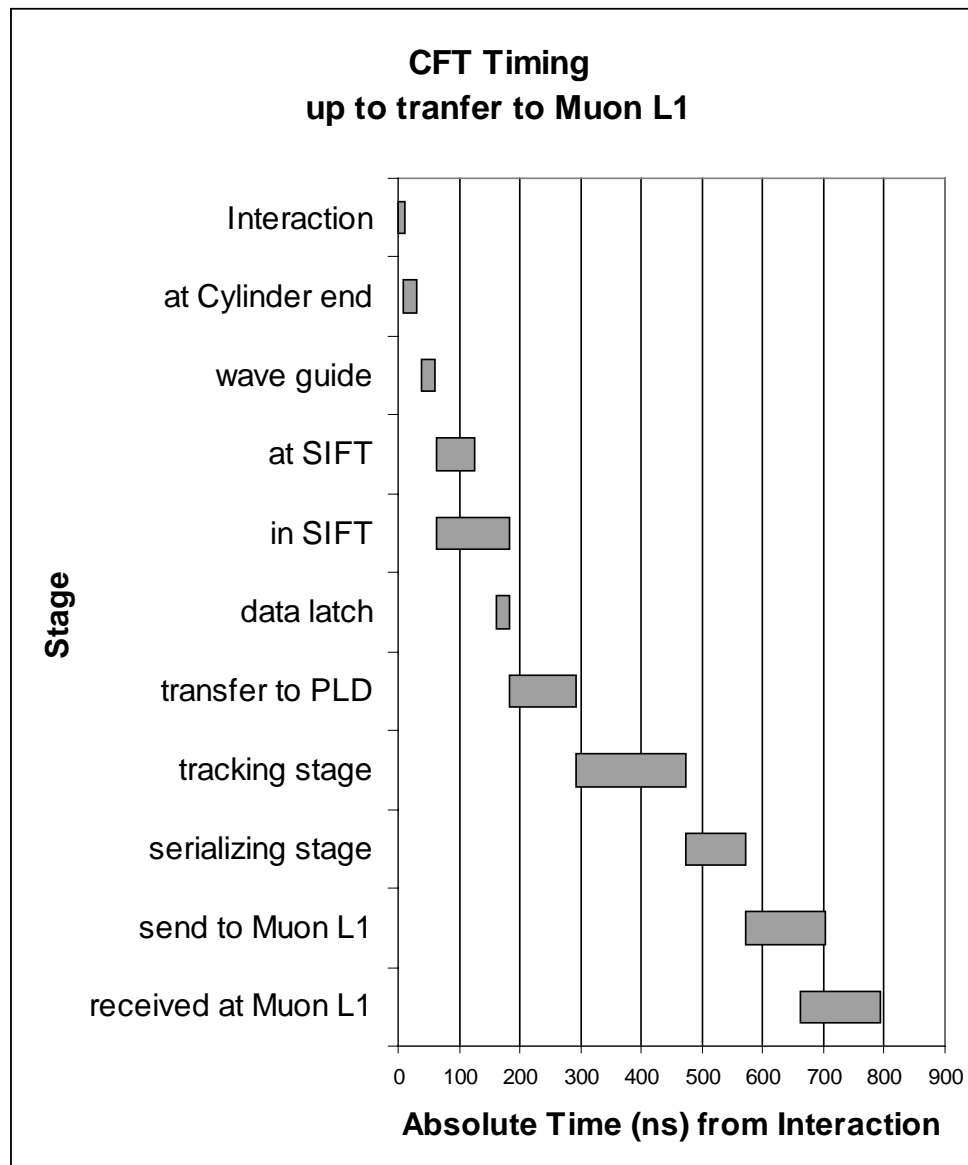
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L1 CFT Review

# Overall System Design

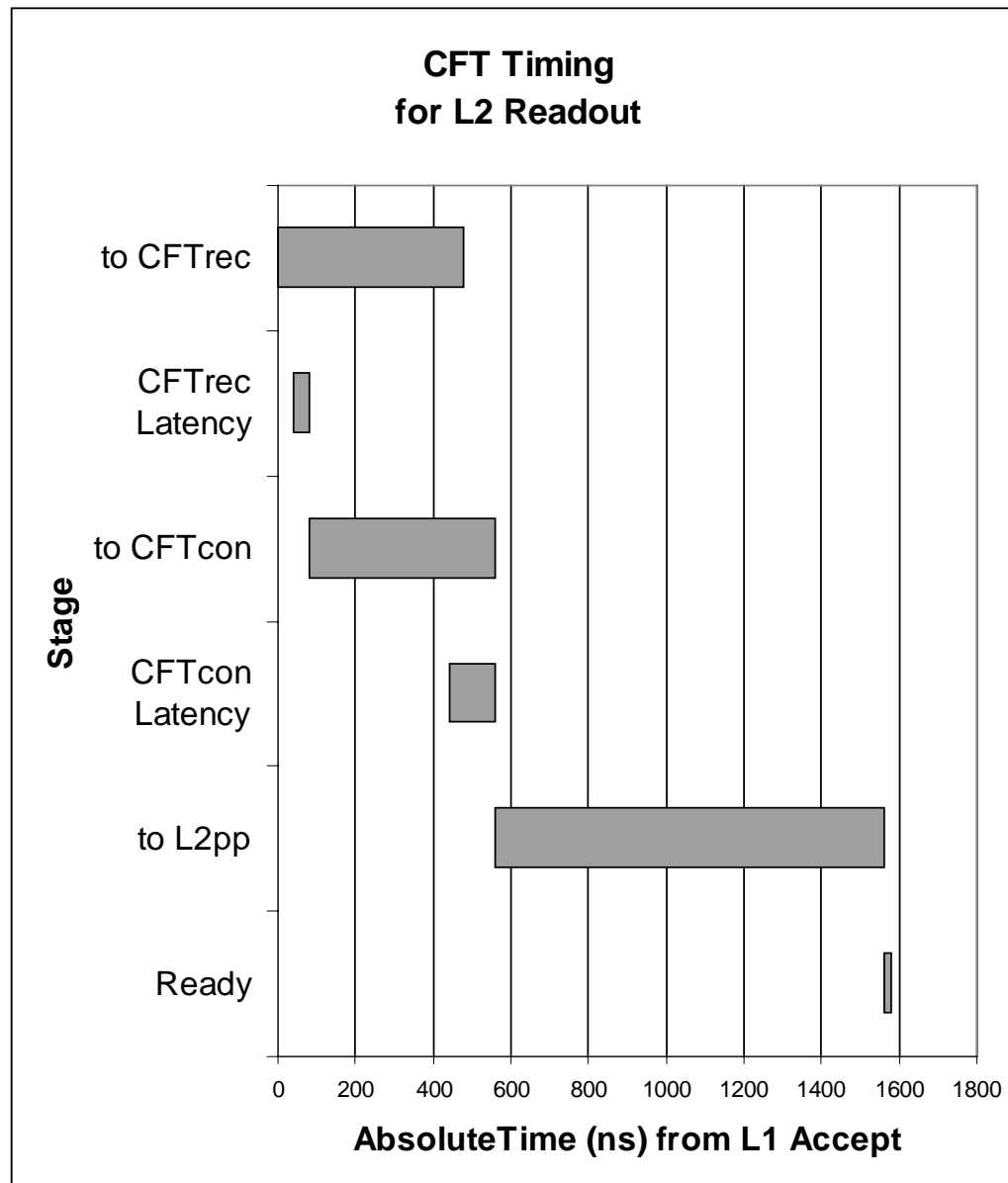


- SIFT data latched and distributed
- Track finding
- Track Indexing
- List to Muon
- CPS and Isolation
- L1 output
- L2 Pipeline
- L2 output



# Timing for L1 Muon

- Calculations of timing to track logic
- Simulations of track logic
- Known transmission times
- 90ns distance



# Time for L2

- Known transmission times
- estimated logic latencies
- 50 tracks to L2pp

# Tracking Algorithm

- Equations
  - ~15,000 terms
- AH Terms
  - $44 \times 24 = 1056$
- Split into Pt Th
  - $4 \times \{ 44 \times 6 \}$
- Priority Select
  - $4 \times \{ 44 \text{ long column} \}$
- Condense
  - $4 \times \{ 6 \text{ tracks} \}$
- Problem - sift through 1056 terms and report out Phi and Pt of those that are TRUE
- FIRST - separate problem into 4 master Pt groups
  - 4 Separate PLDs

# Tracking Algorithm cont.

- SECOND Priority encode
  - keep first object on list
    - efficient use of PLD resources
  - drop the rest
    - no information of dropped items
  - Choose (for each of 44 phi bins) to priority encode 6 Pt bins
    - encode Pt value for highest Pt term TRUE on list
    - result is list of 44 numbers (0=NO Track)

# Tracking Algorithm cont.

- Third
  - Select first 6 number from list that are not 0

# Comparison

- ADVANTAGES over fall 96 baseline
  - much better Pt resolution on tracks in list
  - much better phi resolution of tracks in list
  - uses about the same PLD resources as previous
  - about the same latency as previous
- DIS-advantages
  - does not report out all tracks
  - does not necessarily pick 6 highest Pt in sector



# Numbers for CFT L1

- Deliver Set of 16 numbers to CFTTM
  - FE can count from
    - 0 -> 16 OR
    - 0 -> 64
  - Sum each 8th of CFT to 16 numbers
    - @ the CFTL1con
      - 0 -> 64
  - Sum to global set of 16 numbers
    - 0 -> 64
  - Compare to Trigger Terms

# Track Lists for L2

- 6 Tracks from 4 Pt bins at FE 24 1920
- 50 Tracks from 1/8 of CFT 50 400
  - Take first 50
    - since order in it highest Pt bin -> lowest, get a crude sort
  - Special Sort
    - perform on the fly buffer sort
    - SMALL time penalty - independent of output length
    - can be built long - inexpensive PLDs required
    - Absolute sort in Pt

# Equations

- $Eq(xx) = A(16) \times B(20) \times C(25) \times D(31) \times E(39) \times F(44) \times G(59) \times H(76)$
  - $Eq(xx) = A(16) \times B(21) \times C(25) \times D(31) \times E(39) \times F(44) \times G(59) \times H(76)$
  - $Eq(xx) = A(16) \times B(21) \times C(26) \times D(31) \times E(39) \times F(44) \times G(59) \times H(76)$
  - .....
  - $Eq(xx) = A(16) \times B(21) \times C(26) \times D(32) \times E(40) \times F(45) \times G(59) \times H(76)$
  - $Eq(xx) = A(16) \times B(21) \times C(26) \times D(32) \times E(40) \times F(45) \times G(60) \times H(76)$
- 
- About 15 per AH pair